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Process Optimization Review

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Abstract

This paper is a description of a method called Process Optimization Review (PRO-OP). PRO-OP is a systematic approach used in production operations to identify opportunities to increase profitability while reducing green house gases (GHGs) such as methane. PRO-OP is a systematic approach to assess processes at new and existing facilities with an emphasis on energy efficiency, natural resource conservation and waste minimization. The PRO-OP process uses proven methane reduction methods in the USEPA's Gas STAR Best Management Practices (BMP) to optimize the facility. This methodology can be used in conjunction with a Process Hazards Analysis (PHA) for new facilities and prior to modification of an existing facility.

Introduction

There are approximately 4,000 offshore production platforms and 250,000 onshore production facilities in the continental US¹. Many of these facilities have opportunities to increase profitability through optimization. This paper describes a method called PRO-OP for optimizing oil and gas production facilities. PRO-OP is defined as a systematic approach for evaluating oil and gas production process components (e.g., separators, storage tanks, dehydration units, etc.) whereby natural gas venting emissions (e.g., methane, volatile organic compounds) are reduced, eliminated, captured or destroyed on a cost effective basis.

Justifying and obtaining approval of optimization projects from management often requires that the projects are cost effective and have a net increase in profits².

There are many technologies and methods to reduce vent gas emissions that are readily available to operators. The United States Environmental Protection Agency's (EPA) Natural Gas STAR Program supplies valuable optimization

tools and resources to guide the oil and gas industry. The Natural Gas STAR Program is a flexible and voluntary program focused on helping the oil and gas industry to voluntarily and cost-effectively reduce methane emissions, a potent greenhouse gas. The Natural Gas STAR Program promotes the use of these emission reduction technologies and practices through the program's Best Management Practices (BMPs) and Partner Reported Opportunities (PROs) and in-depth Lessons Learned documents. The extensive array of documents, tools and resources are available online from the EPA at www.epa.gov/gasstar.

The PRO-OP technique divides the oil and gas business into phases: drilling, completion/stimulation, production, and workover operations. Unlike other optimization techniques, where the focus is typically on like devices across a whole operation, the PRO-OP technique is a systematic approach whereby processes and components (separators, heater treaters, compressors, venting/flaring practices) are evaluated for cost effective natural gas reduction opportunities from the start of the process to the end. This PRO-OP technique gives the user a structure to the process of optimization. An application of PRO-OP for a hypothetical new design oil and gas production facility is presented.

Statement of Theory

The PRO-OP approach is analogous to a Process Hazards Analysis (PHA) review. In a PHA review of an oil and gas production facility, the components and processes of the facility are evaluated for identifiable hazards. These hazards are then mitigated through elimination, controls, or other safe guards. The PRO-OP process employs the same thought process. During the PRO-OP review, each component and process in the facility flow scheme is evaluated for vent gas (i.e., methane) emission reduction opportunities.

Once the optimization opportunities are identified, the reviewer determines the mitigation techniques that can be used and then determines whether the mitigation can be implemented cost effectively. The reviewer should ask such questions as, "Can I cost-effectively eliminate the source, or capture for sales, or destroy (e.g., burn in a flare) the vent gas emissions?" Then the reviewer can perform a cost analysis to determine the effectiveness and profitability of optimization.

Description and Application of Process

Many oil and gas production facilities have operational inefficiencies that misuse and waste natural gas. The typical

exploration and production company spends millions of dollars on wells prior to flowing the first cubic foot of natural gas to the surface. Ideally, in its simplest form, the objective is to get all the oil and natural gas produced at the wellhead to the sales meter. Unfortunately that is not realistic because there are technology limitations that result in product loss to the environment. It is realistic that operators can optimize all the processes, components and equipment between the wellhead and the sales point to realize increased profitability.

The strategy is to use PRO-OP during the design phase of new offshore and onshore facilities and production trains, modifications and repairs, and as a tool for ongoing facility evaluation.

PRO-OP makes sense because it focuses on designing and operating processes that are optimized at the start of operations. The benefits include increased profits, conservation of natural resources, reduction in environmental and health liabilities and a reduction in greenhouse gas emissions. Reducing the amount of natural gas vented lowers emissions of volatile organic compounds (VOC), hazardous air pollutants (HAP) and methane. The regulated VOCs include the non-methane, non-ethane hydrocarbons in natural gas. Regulated HAPs from natural gas emissions include benzene, toluene, ethylbenzene and xylenes. A reduction in HAP emissions reduces exposure to onsite operations personnel. Methane, a major component of natural gas, is an identified greenhouse gas that has 21 times more global warming capacity than carbon dioxide.

Typically, field operations personnel are not focused on reducing the venting of natural gas. This means a company should consider designing the facilities optimized from the time of first oil and gas flow. Designs should move away from after-the-fact, end-of-pipe controls for recovering product lost from venting sources. Table 1 lists some optimization techniques that can be used to design or modify an oil and gas production facility.

Another technique that companies should consider, where feasible, is metering the flowrate of vent gas from storage tanks and low-pressure and high-pressure vent and flare systems. This will make the field operators more accountable for product vented to the atmosphere or burned in a flare. Metering gives quantitative data on the amount of vent gas profits lost to the atmosphere. Metering vent and flare systems can provide data on losses from such sources as compressor depressuring, compressor seals, leaking process and relief valves, tank venting, and glycol dehydration units.

Operators striving for optimization should review and implement those Natural Gas STAR Program BMPs, PROs and Lessons Learned that are cost effective for their operations. The documents include methods and technologies for minimizing methane emissions from well completions and down hole and surface facility operations.

Use PRO-OP in the following ways:

1. Develop and implement new facility design specifications using optimization techniques that are cost effective.
2. Incorporate PRO-OP into PHA reviews and Management of Change procedures to identify and implement optimization opportunities for modification of existing facilities.
3. Develop procedures and rewards for field operators to find and document and implement optimization opportunities.

Procedure

The following scenario applies the PRO-OP process to an oil and gas production facility in the design phase. On a new facility design, the PRO-OP process would be performed on the process flow diagram. The operator should examine the facility from wellhead and follow the process flow for each process train (natural gas, oil and produced water) to sales point for opportunities to increase the amount of product (natural gas and oil) entering the pipeline. The operator should determine the existing or typical design used, costs for an optimized and non-optimized design and venting sources for each process train.

Below are some simple optimization techniques that operators presently use for new and existing facility designs.

Table 1- List of major optimization techniques for oil and gas production operations

Process	Optimization Technique to Reduce Venting Emissions
Pneumatics	1. Use low bleed pneumatics in place of high bleed pneumatics 2. Use compressed air for pneumatics
Pressure Relief System	1. Repair or replace leaking relief system components
Production Separators	1. Minimize the operating pressure of separators just upstream of storage tanks or other vessels vented to atmosphere or flared 2. Route flash gas to compressor for injection into sales pipeline
Glycol Dehydration Units Still Column Vent	1. Install condenser, flare or vapor recovery system for still column vent 2. Optimize glycol circulation rates
Glycol Dehydration Units Gas-Condensate-Glycol Separator (Flash Tanks)	1. Route gas to fuel system 2. Install vapor recovery system or route to suction of booster compressor 3. Burn gas in flare
Flare and Vent Systems	1. Repair components leaking into vent system 2. Install vapor recovery systems to recover routine natural gas venting
Internal Combustion Engines	1. Maximize fuel efficiency with controls
Reciprocating Compressors	1. Replace worn compressor rod packing rings and rods
Centrifugal Compressors	1. Replace wet seals with dry seals in centrifugal compressors
Crude Oil Storage Tank	1. Install vapor recovery system to recover vent gases

Case Study

The following demonstrates a PRO-OP case study for an oil and gas production facility producing 500 barrels of oil per day (BOPD) of 40° API gravity oil, 5 million standard cubic feet per day (MMSCFD) of natural gas and 100 barrels of produced water per day. Table 2 displays information on the process components and the non-optimized and optimized operating parameters. Fig. 1 is the non-optimized process flow and Fig. 2 is the optimized process flow.

The non-optimized facility vented to the atmosphere vent gas from the storage tanks, heater treater, glycol dehydrator still column vent and the gas-condensate-glycol separator (flash tank). Also, the non-optimized facility used high bleed pneumatics for the pressure and level controllers. Separator pressures were not optimized in the non-optimized facility.

The PRO-OP facility optimized separator and heater treater pressures and used an EVRUTM to recover vent gas from the storage tanks³, heater treater, glycol dehydrator still column vent and the gas-condensate-glycol separator (flash tank). Low bleed pneumatics were specified for the pressure and level controllers.

Table 2-Operating Parameters for Non-Optimized and PRO-OP Optimized Facility

Process Components	Non-Optimized Operating Parameters	PRO-OP Optimized Operating Parameters
3-Phase High Pressure Separator	850 psig - gas to glycol dehydration then to sales pipeline	850 psig - gas to glycol dehydration then to sales pipeline
3-Phase Low Pressure Separator	80 psig - gas to booster compressor	30 psig - gas to booster compressor
One MMBTU/hr Heater Treater	40 psig - flash gas vented to atmosphere	20 psig - flash gas to EVRU TM
One Triethylene Glycol Dehydration Unit	1. Contactor at 850 psig and 80°F 2. Still column vented to atmosphere 3. Gas-condensate-glycol flash separator operating at 55 psig and 100°F and vented to atmosphere	1. Contactor at 850 psig and 80°F 2. Still column vent routed to EVRU TM 3. Gas-condensate-glycol flash separator operating at 30 psig and 100°F and routed to EVRU TM
One Booster Compressor	100 horsepower; 3 stages; 80 psig suction, 850 psig discharge	100 horsepower; 3 stages; 30 psig suction, 850 psig discharge
Three Oil Storage Tanks	Vent gas to atmosphere	Vent gas recovered by EVRU TM
Two Water Storage Tanks	Vent gas to atmosphere	Vent gas recovered by EVRU TM
10 natural gas level and level safety controllers	High bleed level and pressure controllers	Low bleed level and pressure controllers

Fig. 1-Process Before Optimization

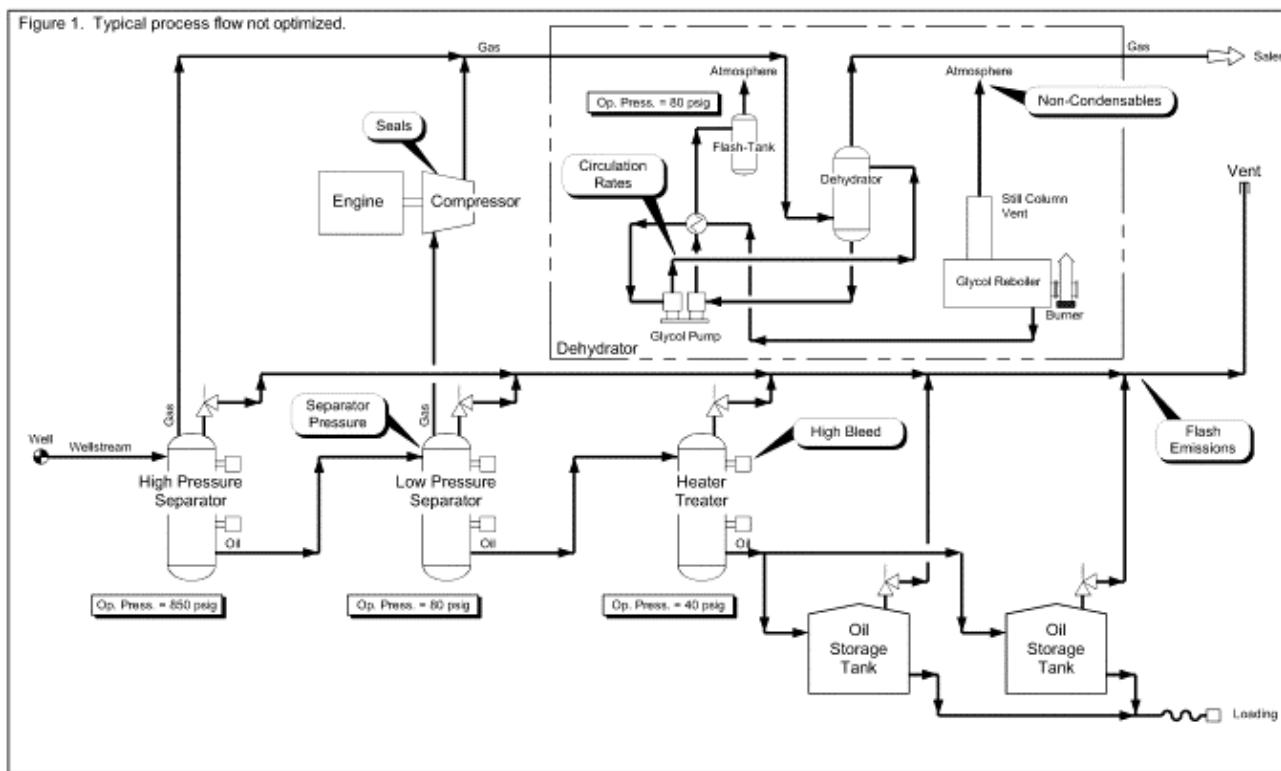


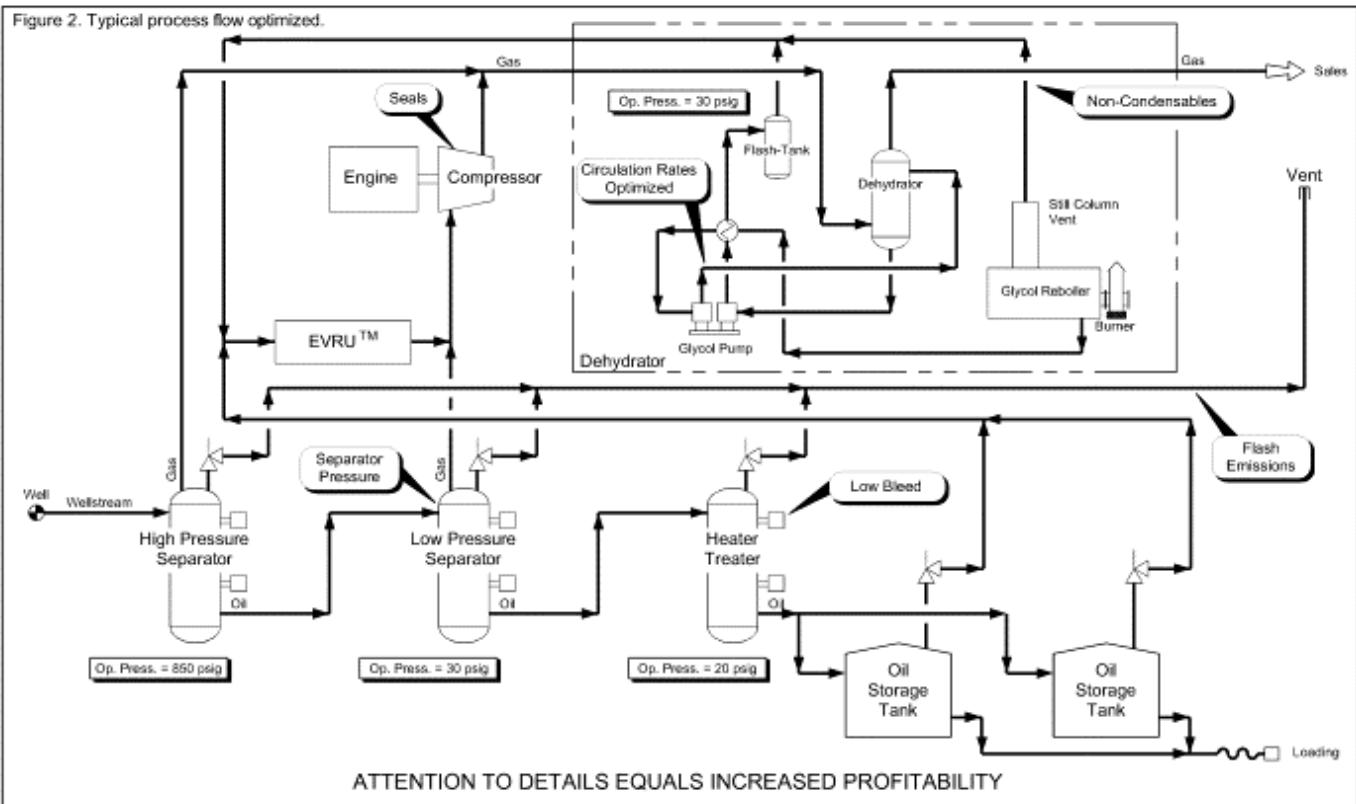
Fig. 2-Process After Optimization

Table 3 displays the results of the PRO-OP design optimization. In the first year of production, the PRO-OP facility would recover \$192,350 of product at a cost of \$117,800. This would result in a net first year savings of \$74,550. The payout for the optimized facility would be less than 8 months.

Table 3- Vent gas emissions and value before and after optimization

Process	Optimization Technique	Gas Recovered (MMBTU/Yr) ^A	Oil Recovered (Barrels/Yr)	Optimization Costs First Year ^B (\$)	Recovered Product Value ^C (\$/year)	First Year Optimization Savings/Costs ^D (\$)
Pneumatics	Low bleed natural gas pneumatics controllers	1,900	0	-2,200	9,500	11,700
Glycol Dehydration Unit	Vent gas from still column and flash tank recovered by EVRU™	50	90	120,000	3,850	62,850
Glycol Dehydration Unit	Flash tank gas routed to vapor recovery system	1,100	0		5,500	
Heater Treater Flash	Vapor recovery by EVRU™	19,200	0		96,000	
Oil Storage Tanks	Vapor recovery by EVRU™	15,500	0		77,500	
Totals:		37,750	90	117,800	192,350	74,550

^ACalculation used 2278 BTU per standard cubic feet for flash gas from heater treater and oil storage tanks. Calculation used 1000 BTU per standard cubic feet for vent gas from pneumatics, glycol dehydration unit flash tank.

^BDifference is cost of optimized process minus non-optimized process. A negative number indicated that the optimized process costs were less than the non-optimized process costs.

^CValue of gas based on \$5.00 per 1,000,000 BTU (MMBTU); value of crude oil based on \$40 per barrel.

^DSavings/Costs = Product Value minus First Year Optimization Costs. A positive number indicates a savings and a negative number indicates a cost.

Table 4 demonstrates that optimization would recover approximately 18.3 MMSCF per year of natural gas and would reduce the emission of methane by 9.6 MMSCF per year. These reductions would be reportable to the EPA's Natural Gas STAR Program.

Table 4-Total Vent gas and methane emissions before and after optimization

Process	Optimization Technique	Natural Gas Vented Not Optimized (MMSCF/yr)	Natural Gas Recovered by Optimization (MMSCF/yr)	Methane Only Emissions Not Optimized (MMSCF/yr)	Methane Recovered by Optimization (MMSCF/yr)
Pneumatics ^E	Low bleed natural gas pneumatics controllers	2	1.9	1.9	1.8
Glycol Dehydration Unit ^E	Vent gas from still column and flash tank recovered by EVRU TM	1.2	1.2	1.1	1.1
Heater Treater Flash Gas ^F	Vapor recovery by EVRU TM	8.4	8.4	5	5
Crude Oil Storage Tanks ^G	Vapor recovery by EVRU TM	6.8	6.8	1.7	1.7
	Totals:	18.4	18.3	9.7	9.6

1 MMSCF = 1,000,000 standard cubic feet at 14.7 psia and 60°F.

^EPneumatics and glycol dehydration unit methane content approximately 95 per cent by volume.

^FHeater treater flash methane content approximately 60 per cent by volume.

^GCrude oil storage tanks methane content approximately 25 per cent by volume.

Conclusions

The use of PRO-OP during the design stage can be cost effective and increase profits for an oil and gas production facility. In addition, this technique should be applied to existing facilities for modifications, repairs, and on going optimization evaluations.

In business terms, managers want to know how it affects their bottom line. They can ask the question, "How does this add value to my operation?" As demonstrated, the PRO-OP method factors in the cost/benefit associated with the identified opportunity.

Using the PRO-OP method to design an optimized facility, the example facility would increase first year revenue by approximately \$192,350 at a cost of approximately \$117,800. This would result in a net first year savings of \$74,550. The annual amount of methane reduction reportable to the EPA's Natural Gas STAR Program would be 9.6 MMSCF.

Companies continue to look for ways to increase profitability while being good stewards of the environment. The PRO-OP method offers a solution to enhance both the financial bottom line and reduce environmental liabilities through the reduction of greenhouse gas emissions.

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